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(54) GEO-BASED CONNECTIVITY AWARENESS FOR BETTER PRODUCTIVITY

(57) A server includes a network interface to interface with mobile computing devices operating within a geographical area, with one of the mobile computing devices providing a request for navigation instructions within the defined geographical area. A geo-connectivity analyzer receives cellular network connectivity metrics for the geographical area, with the cellular network connectivity metric values varying within the geographical area. A network connectivity map is generated by the geo-connectivity analyzer based on the varying cellular network connectivity metrics. The network connectivity map includes areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values. A navigation analyzer generates the navigation instructions between the two geo-locations based on the network connectivity map, with the navigation instructions providing a route that is optimized to include the areas with the strong cellular network connectivity metric values.

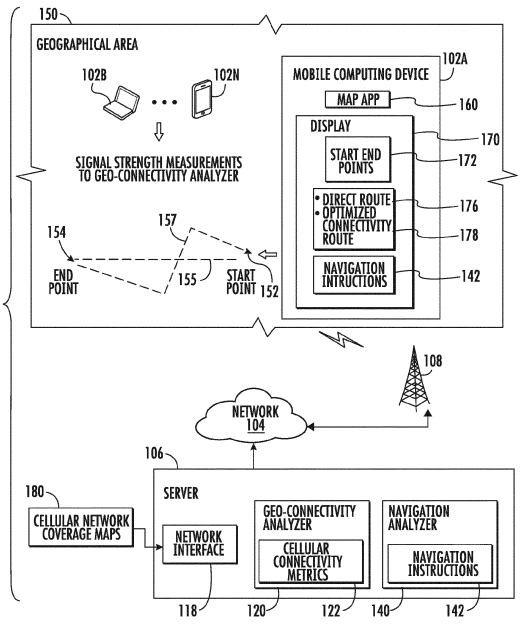

FIG. 3

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Description

Technical Field

[0001] The present disclosure relates to the field of mobile computing devices, and more particularly, to providing network connectivity based navigation instructions to an enterprise mobile users while on the move.

Background

[0002] Enterprise productivity software is aimed at boosting user productivity by allowing workers to reliably and securely work using a computing device regardless of its location. Enterprise productivity software includes XenMobile, XenApp, and online collaboration tools, for example.

[0003] Variability in the quality and strength of Internet connectivity is a challenge when providing consistent and reliable connection experiences for remote and mobile users. Mobile users who are sales professionals, for example, frequently travel and typically need to participate in online meetings and conference calls while travelling on the road.

[0004] However, when a mobile computing device is in use while the user is traveling on the road, an online meeting or conference call may be vulnerable to signal fluctuations, connectivity issues and call disruptions. Consequently, there is a need to improve application performance and user experience for a mobile user while on the move.

Summary

[0005] A server includes a network interface configured to interface with a plurality of mobile computing devices operating within a geographical area, with at least one of the mobile computing devices providing a request for navigation instructions between two geo-locations within the geographical area. A geo-connectivity analyzer may be configured to receive cellular network connectivity metrics for the geographical area, with the cellular network connectivity metric values varying within the geographical area. The geo-connectivity analyzer may also generate a network connectivity map based on the varying cellular network connectivity metrics, with the network connectivity map including areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values. A navigation analyzer may be coupled to the geo-connectivity analyzer and may be configured to generate the navigation instructions between the two geo-locations based on the network connectivity map. The navigation instructions may provide a route that is optimized to include the areas with the strong network connectivity metric values.

[0006] The route provided by the navigation analyzer may not be the most direct route between the two geo-locations within the geographical area. Network connectivity based navigation instructions are intended to enable business continuity and uninterrupted application access for enterprise mobile users while on the move. This advantageously helps to boost employee productivity by allowing users to work reliably and securely while traveling. The navigation routes optimize cellular network connectivity instead of the shortest distance or the shortest time.

[0007] The cellular network connectivity metrics may be based on at least one cellular network connectivity map from at least one cellular network service provider operating within the geographical area.

[0008] The cellular network connectivity metrics may be based on signal strength measurements provided by the plurality of mobile computing devices operating within the geographical area.

[0009] The signal strength measurements provided by each respective mobile computing device may further include geo-coordinates on where the signal strength measurements were made. The signal strength measurements provided by each respective mobile computing device may also include identification of a cellular network service provider operating with the respective mobile computing device.

[0010] The navigation analyzer may be further configured to provide the navigation instructions via the network interface to the mobile computing device providing the request.

[0011] Another aspect is directed to a method for operating a server as described above to generate network connectivity based navigation instructions for a mobile computing device.

[0012] Yet another aspect is directed to a non-transitory computer readable medium for a server as described above, with the non-transitory computer readable medium having a plurality of computer executable instructions for causing the server to generate network connectivity based navigation instructions.

Brief Description of the Drawings

[0013]

FIG. 1 illustrates an embodiment of a network environment that provides network connectivity based navigation instructions to mobile computing devices executing a map application.

FIG. 2 is a block diagram a general computing device useful as an embodiment of the servers or the mobile computing devices illustrated in FIG. 1

FIG. 3 is a more detailed block diagram of a server and mobile computing device operating within the network environment as illustrated in FIG. 1.

FIG. 4 is a display of a network connectivity map generated by the geo-connectivity analyzer illustrated in FIG. 3.

FIG. 5 is a flow diagram illustrating the steps for generating network connectivity based navigation instructions for the mobile computing device illustrated in FIG. 3.

Detailed Description

[0014] The present description is made with reference to the accompanying drawings, in which exemplary embodiments are shown. However, many different embodiments may be used, and thus the description should not be construed as limited to the particular embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete. Like numbers refer to like elements throughout.

[0015] As a general introduction, a server is configured to provide network connectivity based navigation instructions between any two geolocations within a geographical area. Network connectivity based navigation instructions are intended to enable business continuity and uninterrupted application access for enterprise mobile users while on the move. The navigation routes optimize cellular network connectivity instead of the shortest distance or the shortest time. This means that the navigation route provided to an enterprise mobile user may be longer as compared to other available routes so that continuity disruptions are minimized.

[0016] Referring initially to FIGS. 1-2, a non-limiting illustrative network environment useful for practicing embodiments described herein is first described. FIG. 1 illustrates one embodiment of a computing environment **100** that includes one or more mobile computing devices **102A-102N** in communications with one or more servers **106A-106N** via one or more networks **104.** One or more cellular base stations **108** may be associated with a network provider to relay communications to and from the mobile computing devices **102A-102N.** The mobile computing devices **102A-102N** may be generally referred to by reference **102**, and the servers **106A-106N** may be generally referred to by reference **106.**

[0017] In some embodiments, the mobile computing device **102** may execute, operate or otherwise provide an application that may be any one of the following: software; a program; executable instructions; a virtual machine; a hypervisor; a web browser; a web-based client; a client-server application; a thin-client computing client; an ActiveX control; a Java applet; software related to voice over internet protocol (VoIP) communications like a soft IP telephone; an application for streaming video and/or audio; an application for facilitating real-time-data communications; a HTTP client; a FTP client; an Oscar client; a Telnet client; or any other set of executable instructions.

[0018] Still other embodiments include a mobile computing device **102** that displays application output generated by an application remotely executing on a server **106**. In these embodiments, the client device **102** may display the application output in an application window, a browser, or other output window. In one embodiment, the application may be a desktop, while in other embodiments the application may be an application that generates a desktop.

[0019] In some embodiments, a server **106** may execute a remote presentation client or other client or program that uses a thin-client or remote-display protocol to capture display output generated by an application executing on a server **106** and transmits the application display output to a mobile computing device **102**.

[0020] A server **106** may be any remote machine type such as, for example: a file server; an application server; a web server; a proxy server; an appliance; a network appliance; a gateway; an application gateway; a gateway server; a virtualization server; a deployment server; a Secure Sockets Layer Virtual Private Network (SSL VPN) server; a firewall; a web server; an application server or as a master application server; a server executing an active directory; or a server executing an application acceleration program that provides firewall functionality, application functionality, or load balancing functionality.

[0021] In some embodiments, a server **106** may be a RADIUS server that includes a remote authentication dial-in user service. In still other embodiments, a server **106** is a blade server. In yet other embodiments, a server **106** executes a virtual machine providing, to a mobile computing device **102**, access to a computing environment.

[0022] The server **106** may, in some embodiments, execute any one of the following applications: a thin-client application using a thin-client protocol to transmit application display data to a client; or a remote display presentation application. Another embodiment includes a server **106** that is an application server such as: an email server that provides email services; a web or Internet server; a desktop sharing server; a collaboration server; or any other type of application server. Still other embodiments include a server **106** that executes a hosted server application, such as a remote meeting or desktop sharing application.

[0023] In some embodiments, a server machine **106** may execute an application on behalf of a user of a mobile computing device **102**. In other embodiments, a server **106** executes a virtual machine, which provides an execution session within which applications execute on behalf of a mobile computing device **102**. In one of these embodiments, the execution session is a hosted desktop session. In another of these embodiments, the execution session provides

access to a computing environment, which may comprise one or more of: an application, a plurality of applications, a desktop application, and a desktop session in which one or more applications may execute.

[0024] A mobile computing device **102** may be, for example, a client node that seeks access to resources provided by a server **106**. In other embodiments, the server **106** may provide mobile computing devices **102** with access to hosted resources. The server **106**, in some embodiments, functions as a master node such that it communicates with one or more mobile computing device **102** or servers **106**. In some embodiments, the master node may identify and provide address information associated with a server **106** hosting a requested application, to one or more mobile computing devices **102** or servers **106**.

[0025] In yet another embodiment, the server **106** presents the response to the request to a mobile computing device **102** using a web interface. In one embodiment, the mobile computing device 102 communicates directly with the server **106** to access the identified application. In another embodiment, the mobile computing device **102** receives output data, such as display data, generated by an execution of the identified application on the server **106**.

[0026] One or more mobile computing devices **102**, one or more servers **106**, or both may transmit data over one or more networks **104** installed within the computing environment **100**. The network **104** may comprise one or more sub-networks, and may be installed between any combination of the mobile computing devices **102** and servers **106.**

[0027] In some embodiments, the network **104** may be: a local-area network (LAN); a metropolitan area network (MAN); a wide area network (WAN); a primary network comprised of multiple sub-networks located between the mobile computing devices **102** and the servers **106**; a primary public network with a private sub-network; a primary private network with a public sub-network; or a primary private network with a private sub-network.

[0028] Still further embodiments include a network **104** that may be any of the following network types: a point to point network; a broadcast network; a telecommunications network; a data communication network; a computer network; an Asynchronous Transfer Mode (ATM) network; a Synchronous Optical Network (SONET) network; a Synchronous Digital Hierarchy (SDH) network; a wireless network; a wireline network; or a network **104** that includes a wireless link where the wireless link may be an infrared channel or satellite band.

[0029] The network topology of the network **104** may differ within different embodiments. Additional embodiments may include a network **104** of mobile telephone networks that use a protocol to communicate among mobile devices, where the protocol may be any one of the following: Advanced Mobile Phone System (AMPS); Time Division Multiple Access (TDMA); Code Division Multiple Access (CDMA); Global System for Mobile Communications (GSM); General Packet Radio Service (GPRS); Universal Mobile Telecommunications System (UMTS); Evolution-Data Optimized (EV-DO); Long Term Evolution (LTE); or any other protocol able to transmit data among mobile devices like 802.11, Bluetooth, and Near Field Communication.

[0030] FIG. 2 depicts a block diagram of a general computing device **200** useful for practicing an embodiment of the mobile computing device **102** or the server **106**. The illustrated computing device **200** includes a central processing unit (CPU) **221** and a main memory unit **222**. The processing unit **221** communicates with the main memory **222** via a system bus **250**.

[0031] The system bus **250** communicates with the following components: a processing unit **221**; a main memory **122**; storage memory **228**; an input/output (I/O) controller **123**; display devices **224A-224N**; an installation device **216**; and a network interface **218.** In one embodiment, the storage memory **228** includes: an operating system, software routines, and a client agent **220.** The I/O controller **223**, in some embodiments, is further connected to a keyboard **226**, and a pointing device **227**. Other embodiments may include an I/O controller **223** connected to more than one input/output device **230A-230N**.

[0032] In some embodiments, the processing unit **221** may include one or more processing cores. For example, the processing unit **221** may have two cores, four cores, eight cores, etc. In one embodiment, the processing unit **221** may comprise one or more parallel processing cores. The processing cores of the processing unit **221** may in some embodiments access available memory as a global address space, or in other embodiments, memory within the computing device **200** may be segmented and assigned to a particular core within the processing unit **221**.

[0033] In one embodiment, the one or more processing cores or processors in the computing device **200** may each access local memory. In still another embodiment, memory within the computing device **200** may be shared among one or more processors or processing cores, while other memory may be accessed by particular processors or subsets of processors.

[0034] In embodiments where the computing device **200** includes more than one processing unit **221**, the multiple processing units **221** may be included in a single integrated circuit (IC). These multiple processors, in some embodiments, may be linked together by an internal high speed bus, which may be referred to as an element interconnect bus.

[0035] The computing device **200**, in some embodiments, may include a graphics processor or a graphics-processing unit. The graphics processing unit may include any combination of software and hardware, and may further input graphics data and graphics instructions, render a graphic from the inputted data and instructions, and output the rendered graphic. In some embodiments, the graphics processing unit may be included within the processing unit **221**. In other embodiments, the computing device **200** may include one or more processing units **221**, where at least one processing unit **221** is

dedicated to processing and rendering graphics.

[0036] The local system bus **250** may, in some embodiments, also be used by the central processing unit **221** to communicate with more than one type of I/O device **230A-230N**. Other embodiments of the computing machine **200** include an I/O device **230A-230N** that is a video display **224** that communicates with the CPU **221**.

[0037] One embodiment of the computing device **200** provides support for any one of the following installation devices **216**: a CD-ROM drive, a CD-R/RW drive, a DVD-ROM drive, tape drives of various formats, a universal serial bus (USB) device, Secure Digital card, Preboot Execution Environment (PXE) firmware, a bootable medium, a bootable CD, a hard-drive or any other device suitable for installing applications or software.

[0038] Applications may in some embodiments include a client agent **220**, or any portion of a client agent **220**. The computing device **200** may further include a storage device **228** that may be either one or more hard disk drives, or one or more redundant arrays of independent disks; where the storage device is configured to store an operating system, software, programs applications, or at least a portion of the client agent **220**. A further embodiment of the computing device **200** includes an installation device **216** that is used as the storage device **228**.

[0039] The computing device **200** may further include a network interface **218** to interface to a LAN, WAN or the Internet through a variety of connections including, but not limited to, standard telephone lines, LAN or WAN links (e.g., 802.11, T1, T3, 56 kb, X.25), broadband connections (e.g., Integrated Services Digital Network (ISDN), Frame Relay, ATM, Gigabit Ethernet, Ethernet-over-SONET), wireless connections, or some combination of any or all of the above. Connections may also be established using a variety of communication protocols (e.g., TCP/IP, Ethernet, Attached Resource Computer Network (ARCNET), SONET, SDH, Fiber Distributed Data Interface (FDDI), RS232, RS485, IEEE 802.11, IEEE 802.11a/b/g/n, CDMA, GSM, Wi-Fi, WiMax and direct asynchronous connections).

[0040] One version of the computing device **200** includes a network interface **218** able to communicate with additional computing devices via any type and/or form of gateway or tunneling protocol such as Secure Socket Layer (SSL) or Transport Layer Security (TLS). Versions of the network interface **218** may comprise any one of: a built-in network adapter; a network interface card; a Personal Computer Memory Card International Association (PCMCIA) network card; a card bus network adapter; a wireless network adapter; a USB network adapter; a modem; or any other device suitable for interfacing the computing device **200** to a network capable of communicating and performing the methods and systems described herein.

[0041] Embodiments of the computing device **200** include any one of the following I/O devices **230A-230N**: a keyboard **226**; a pointing device **227**; mice; trackpads; an optical pen; trackballs; microphones; drawing tablets; video displays; speakers; inkjet printers; laser printers; and dye-sublimation printers; or any other input/output device able to perform the methods and systems described herein.

[0042] An I/O controller **223** may in some embodiments connect to multiple I/O devices **203A-230N** to control the one or more I/O devices. Some embodiments of the I/O devices **230A-230N** may be configured to provide storage or an installation device **216**, while others may provide a USB interface for receiving USB storage devices.

[0043] Still other embodiments include an I/O device **230** that may be a bridge between the system bus **250** and an external communication bus, such as: a USB bus; an RS-232 serial connection; a Small Computer System Interface (SCSI) bus; an IEEE 1394 bus; an Ethernet bus; a Gigabit Ethernet bus; an ATM bus; a High Performance Parallel Interface (HIPPI) bus; a Super HIPPI bus; a SerialPlus bus; a Scalable Coherent Interface (SCI) bus; a FibreChannel bus; or a Serial Attached SCSI (SAS) bus.

[0044] In some embodiments, the computing machine **200** may connect to multiple display devices **224A-224N**, in other embodiments the computing device **200** may connect to a single display device **224**, while in still other embodiments the computing device **200** connects to display devices **224A-224N** that are the same type or form of display, or to display devices that are different types or forms.

[0045] Embodiments of the display devices **224A-224N** may be supported and enabled by the following: one or multiple I/O devices **230A-230N**; the I/O controller **223**; a combination of I/O device(s) **230A-230N** and the I/O controller **223**; any combination of hardware and software able to support a display device **224A-224N**; any type and/or form of video adapter, video card, driver, and/or library to interface, communicate, connect or otherwise use the display devices **224A-224N**. The computing device **200** may in some embodiments be configured to use one or multiple display devices **224A-224N**.

[0046] In some embodiments, the computing machine **200** may execute any operating system, while in other embodiments the computing machine **200** may execute any of the following operating systems: any embedded operating system; any real-time operating system; any remote operating system; any operating systems for mobile computing devices; or any other operating system.

[0047] In still another embodiment, the computing machine **200** may execute multiple operating systems. For example, the computing machine **200** may execute a virtualization platform that may execute or manage a virtual machine executing a first operating system, while the computing machine **200** executes a second operating system different from the first operating system.

[0048] The computing machine **200** may be embodied in any one of the following computing devices: a computing

workstation; a desktop computer; a laptop or notebook computer; a server; a handheld computer; a mobile telephone; a portable telecommunication device; a media playing device; a gaming system; a mobile computing device; a netbook; a digital audio player or any other type and/or form of computing, telecommunications or media device that is capable of communication and that has sufficient processor power and memory capacity to perform the methods and systems described herein.

[0049] In other embodiments the computing machine **200** may be a mobile device such as any one of the following mobile devices: a cellular telephone or personal digital assistant (PDA); a smart phone; a handheld computing device; any computing device that has different processors, operating systems, and input devices consistent with the device; or any other mobile computing device capable of performing the methods and systems described herein.

[0050] In one embodiment, the computing device **200** may be a digital audio player which functions as both a portable media player and as a mass storage device. In some embodiments, the computing device **200** may have different processors, operating systems, and input devices consistent with the device.

[0051] In some embodiments, the computing device **200** comprises a combination of devices, such as a mobile phone combined with a digital audio player or portable media player. In one of these embodiments, the computing device **200** is a combination digital audio player and mobile phone. In another of these embodiments, the computing device **200** is a smartphone. In another of these embodiments, the computing device **200** is a tablet computer.

[0052] Referring now to FIG. 3, generation of network connectivity based navigation instructions **142** between any two geolocations within a geographical area **150** will be discussed. The illustrated embodiment includes mobile computing devices **102A-102N** operating within the geographical area **150** and in communications with a server **106** via a cellular base station **108** and a network **104**. The navigation instructions **142** are provided from the server **106** to the mobile computing devices **102A** making the request.

[0053] The mobile computing devices **102A-102N** may be laptop computers or smart phones, for example, executing enterprise productivity software, such as XenMobile. Mobile users who are sales professionals, for example, frequently travel and typically need to participate in online meetings and conference calls while travelling on the road. However, such meetings or conference calls may be interrupted due to cellular network connectivity issues.

[0054] As readily appreciated by those skilled in the art, signal strength levels may fluctuate among mobile computing devices **102A-102N** operating within the geographical area **150**. Operation of the mobile computing devices **102A-102N** is based on a cellular service provider, such as Vodafone, Sprint, Verizon, T-Mobile, or AT&T, for example. Coverage as determined in signal strength levels may vary among the different cellular service providers.

[0055] To assist the mobile user with navigation instructions **142** while traveling within the geographical area **150**, at least one of the mobile computing devices **102A** include a map application **160**, such as Google Maps, for example. When the map application **160** is executed by the mobile computing device **102A**, the mobile user is prompted on display **170** via display prompt **172** to enter two geo-locations within the geographical area **150**, i.e., a start point **152** and an end point **154**.

[0056] The mobile user is also prompted to select the type of route desired. Display prompt **176** on the display **170** allows the mobile user to select navigation instructions for a route **155** that is the shortest distance between the two geo-locations **152**, **154** regardless of cellular network connectivity metrics. Display prompt **178** on the display **170** allows the mobile user to select navigation instructions for a route **157** that is optimized for cellular network connectivity metrics.

[0057] If the mobile user is to participate in an online meeting or conference call while traveling, the mobile user will select display prompt **178** for the route **157** that is optimized for cellular network connectivity metrics. Cellular network connectivity metrics include signal strength levels, for example. The higher the signal strength level the less likely the online meeting or conference call will be interrupted.

[0058] The server **106** includes a network interface **118** that is configured to interface with the mobile computing devices **102A-102N** operating within the geographical area **150**, with at least one of the mobile computing devices, e.g., **102A**, providing the request for navigation instructions within the geographical area **150**.

[0059] The server **106** further includes a geo-connectivity analyzer **120** and a navigation analyzer **140**. The geo-connectivity analyzer **120** is configured to receive cellular network connectivity metrics **122** for the geographical area **150**. The cellular network connectivity metric values typically vary within the geographical area **150**.

[0060] The geo-connectivity analyzer **120** generates a network connectivity map **182**, as illustrated in FIG. 4, based on the varying cellular network connectivity metrics. The network connectivity map **182** includes areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values. The illustrated network connectivity map **182** is in the form of a heat map and uses dark shading to represent strong cellular network connectivity metric values, light shading to represent weak cellular network connectivity metric values, and no shading to represent no data collected.

[0061] The navigation analyzer **140** is coupled to the geo-connectivity analyzer **120** and is configured to generate the navigation instructions **142** between the two geo-locations **152**, **154** based on the network connectivity map **182**. When display prompt **178** is selected by the mobile user, the navigation instructions **142** provide a route that is optimized to include the areas with the strong cellular network connectivity metric values.

[0062] Still referring to the network connectivity map **182**, a mobile user has a start point **152** along Highway 528 and an end point **154** along Interstate 95. The most direct or shortest route **155** is for the mobile user to exit from Highway 528 onto Highway 520 which then connects with Interstate 95. However, areas along Highway 520, i.e., route **155**, have weak cellular network connectivity metric values. Consequently, the navigation instructions **142** instruct the mobile user to use the optimized network connectivity route **157**. Here, the mobile user does not exit onto Highway 520 and instead remains on Highway 528 until Interstate 95 is reached, then the mobile user continues south on Interstate 95 to the end point **154**.

[0063] The cellular network connectivity metrics **122** may be provided from multiple sources. One of the sources is from the cellular network providers in the form of cellular network connectivity maps **180**. Vodafone, Sprint, Verizon, T-Mobile, and AT&T are cellular network providers that may provide their respective cellular network connectivity maps **180** for the geographical area **150.** Coverage as determined in signal strength levels may vary among the different cellular network providers.

[0064] The cellular network connectivity maps **180** may also be referred to as heat maps. As discussed above, a heat map is a representation of data in the form of a map or diagram in which data values are represented as colors. The cellular network connectivity maps **180** may be similar to the network connectivity maps **182** generated by the geo-connectivity analyzer **120**. The data being represented in the cellular network connectivity maps **180** is signal strength values, which may be point in time values. These values may also be updated in real time.

[0065] Another source providing cellular network connectivity metrics **122** are the other mobile computing devices **102B-102N** operating within the geographical area **150** other than the mobile computing device **102A** requesting the navigation instructions **142.** Each of the mobile computing devices **102B-102N** may automatically provide cellular connectivity metrics **122** to the geo-connectivity analyzer **120**, as readily appreciated by those skilled in the art. In other embodiments, the mobile computing device **102A** requesting the navigation instructions **142** may also provide cellular network connectivity metrics **122** to the geo-connectivity analyzer **120**.

[0066] The cellular connectivity metrics **122** include signal strength measurements provided by each respective mobile computing devices **102B-102N** operating within the geographical area **150.** The geo-location of each mobile computing device **102B-102N** providing the signal strength measurement, along with the cellular network provider for each mobile computing device **102B-102N** are also provided to the geo-connectivity analyzer **120**.

[0067] In other words, the information provided by the mobile computing devices **102B-102N** operating within the geographical area **150** includes geo-location, cellular network signal strength values, vendor and other business application performance metrics. For illustration purposes, a sample of collected information from the mobile computing devices **102B-102N** may be as follows:

```
{
 "location": {
 "lat": 51.0,
 "lng": -0.1
 },
 "accuracy": 1200.4
 }
 {
 "homeMobileCountryCode": 310,
 "homeMobileNetworkCode": 410,
 "radioType": "gsm",
 "carrier": "Vodafone",
 "signalStrength": -60 dBm,
 "considerIp": "true",
 }
```

[0068] The information provided by the mobile computing devices **102B-102N** is correlated with the cellular network connectivity maps **180** to enable selection of navigation routes optimized for the best cellular network connectivity at a given point of time. This correlation by the geo-connectivity analyzer **120** is used to generate the network connectivity maps **182** which allows a navigation route with the best network coverage/ connectivity to be selected so as to enable better user experience, productivity and business continuity. Another advantageous feature of the server is to alert a mobile user about connectivity issues and potential application performance degradation while on the move.

[0069] Referring now to the flow diagram **300** in FIG. 5, a method for generating network connectivity based navigation instructions **142** for a mobile computing device **102** will be discussed. From the Start (Block **302**), the method comprises interfacing with a plurality of mobile computing devices **102A-102N** operating within a geographical area **150** at Block **304**, with at least one of the mobile computing devices **102A** providing a request for navigation instructions between two geo-locations **152**, **154** within the geographical area **150**.

[0070] Cellular network connectivity metrics **122** are received at Block **306** for the geographical area **150.** The cellular network connectivity metric values **122** vary within the geographical area **150.** A network connectivity map **182** is generated at Block **308** based on the varying cellular network connectivity metrics **122**. The network connectivity map **182** includes areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values. Better connectivity is provided to the mobile computing device **102A** when operating in the areas with the strong cellular network connectivity metric values. The navigation instructions **172** between the two geo-locations **152, 154** are generated at Block **310** based on the network connectivity map **182**. The navigation instructions **142** provides a route that is optimized to include the areas with the strong cellular network connectivity metric values. The method ends at Block **312**.

[0071] Yet another aspect is directed to a non-transitory computer readable memory for a server **106** as described above, with the non-transitory computer readable medium having a plurality of computer executable instructions for causing the server **106** to perform the steps of interfacing with a plurality of mobile computing devices **102A-102N** operating within a geographical area **150**, with at least one of the mobile computing devices **102A** providing a request for navigation instructions between two geo-locations **152**, **154** within the geographical area **150.** The steps further include receiving cellular network connectivity metrics **122** for the geographical area **150.** The cellular network connectivity metric values **122** vary within the geographical area **150.** A network connectivity map **182** is generated based on the varying cellular network connectivity metrics **122**. The network connectivity map **182** includes areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values. The navigation instructions **142** between the two geo-locations **152**, **154** are generated based on the network connectivity map **182**. The navigation instructions **142** provides a route that is optimized to include the areas with the strong cellular network connectivity metric values.

[0072] Many modifications and other embodiments will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is understood that the disclosure is not to be limited to the specific embodiments disclosed, and that modifications and embodiments are intended to be included within the scope of the appended claims.

Claims

1. A server comprising:

a network interface configured to interface with a plurality of mobile computing devices operating within a geographical area, with at least one of the mobile computing devices providing a request for navigation instructions between two geo-locations within the geographical area;
a geo-connectivity analyzer configured to

receive cellular network connectivity metrics for the geographical area, with the cellular network connectivity metric values varying within the geographical area, and
generate a network connectivity map based on the varying cellular network connectivity metrics, with the network connectivity map including areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values; and

a navigation analyzer coupled to said geo-connectivity analyzer and configured to generate the navigation instructions between the two geo-locations based on the network connectivity map, with the navigation instructions providing a route that is optimized to include the areas with the strong cellular network connectivity metric values.

2. The sever according to Claim 1 wherein the route provided by said navigation analyzer is not the most direct route between the two geo-locations within the geographical area.

3. The server according to Claim 1 wherein the cellular network connectivity metrics are based on at least one cellular network connectivity map from at least one cellular network service provider operating within the geographical area.

4. The sever according to Claim 1 wherein the cellular network connectivity metrics are based on signal strength measurements provided by the plurality of mobile computing devices operating within the geographical area.

5. The sever according to Claim 4 wherein the signal strength measurements provided by each respective mobile computing device further include geo-coordinates on where the signal strength measurements were made.

6. The sever according to Claim 4 wherein the signal strength measurements provided by each respective mobile computing device includes identification of a cellular network service provider operating with the respective mobile computing device.

7. The sever according to Claim 1 wherein said navigation analyzer is further configured to provide the navigation instructions via said network interface to the mobile computing device providing the request.

8. A method for operating a server to generate navigation instructions for a mobile computing device, the method comprising:

interfacing with a plurality of mobile computing devices operating within a geographical area, with at least one of the mobile computing devices providing a request for navigation instructions between two geo-locations within the geographical area;
receiving cellular network connectivity metrics for the geographical area, with the cellular network connectivity metric values varying within the geographical area;
generating a network connectivity map based on the varying cellular network connectivity metrics, with the network connectivity map including areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values; and
generating the navigation instructions between the two geo-locations based on the network connectivity map, with the navigation instructions providing a route that is optimized to include the areas with the strong cellular network connectivity metric values.

9. The method according to Claim 8 wherein the route is not the most direct route between the two geo-locations within the geographical area.

10. The method according to Claim 8 wherein the cellular network connectivity metrics are based on at least one cellular network connectivity map from at least one cellular network service provider operating within the geographical area.

11. The method according to Claim 8 wherein the cellular network connectivity metrics are based on signal strength measurements provided by the plurality of mobile computing devices operating within the geographical area.

12. The method according to Claim 11 wherein the signal strength measurements provided by each respective mobile computing device further include geo-coordinates on where the signal strength measurements were made.

13. The method according to Claim 11 wherein the signal strength measurements provided by each respective mobile computing device includes identification of a cellular network service provider operating with the respective mobile computing device.

14. The method according to Claim 8 further comprising providing the navigation instructions to the mobile computing device providing the request.

15. A non-transitory computer readable medium for a server, with the non-transitory computer readable medium having a plurality of computer executable instructions for causing the server to perform steps comprising:

interfacing with a plurality of mobile computing devices operating within a geographical area, with at least one of the mobile computing devices providing a request for navigation instructions between two geo-locations within the geographical area;
receiving cellular network connectivity metrics for the geographical area, with the cellular network connectivity metric values varying within the geographical area;
generating a network connectivity map based on the varying cellular network connectivity metrics, with the network connectivity map including areas with strong cellular network connectivity metric values and areas with weak cellular network connectivity metric values; and
generating the navigation instructions between the two geo-locations based on the network connectivity map, with the navigation instructions providing a route that is optimized to include the areas with the strong cellular network connectivity metric values.

16. The non-transitory computer readable medium according to Claim 15 wherein the route is not the most direct route between the two geo-locations within the geographical area.

17. The non-transitory computer readable medium according to Claim 15 wherein the cellular network connectivity metrics are based on at least one cellular network connectivity map from at least one cellular network service provider operating within the geographical area.

18. The non-transitory computer readable medium according to Claim 15 wherein the cellular network connectivity metrics are based on signal strength measurements provided by the plurality of mobile computing devices operating within the geographical area.

19. The non-transitory computer readable medium according to Claim 18 wherein the signal strength measurements provided by each respective mobile computing device further include geo-coordinates on where the signal strength measurements were made.

20. The non-transitory computer readable medium according to Claim 18 wherein the signal strength measurements provided by each respective mobile computing device includes identification of a cellular network service provider operating with the respective mobile computing device.

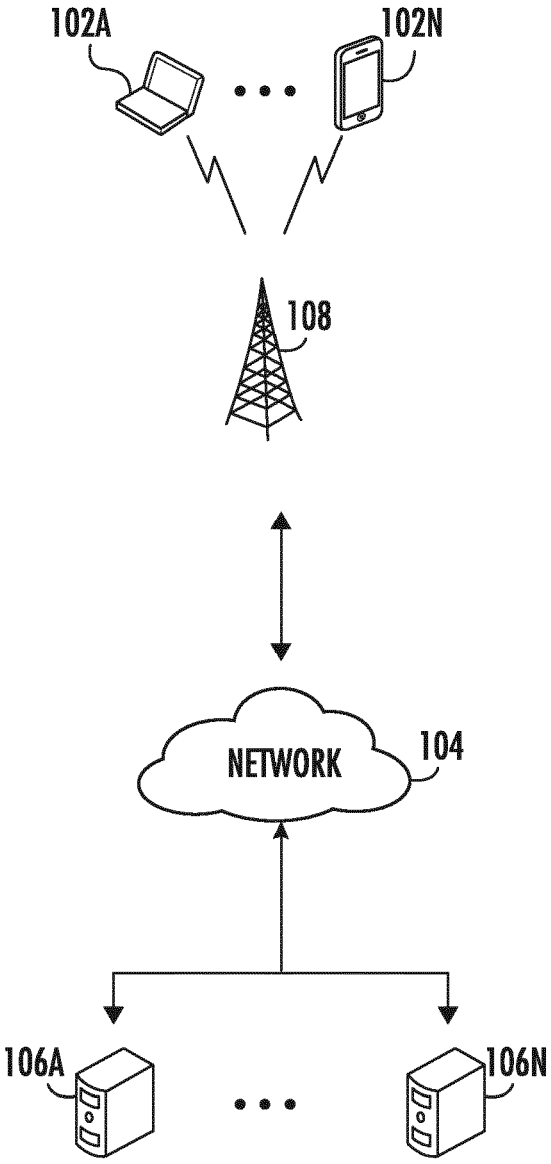

FIG. 1

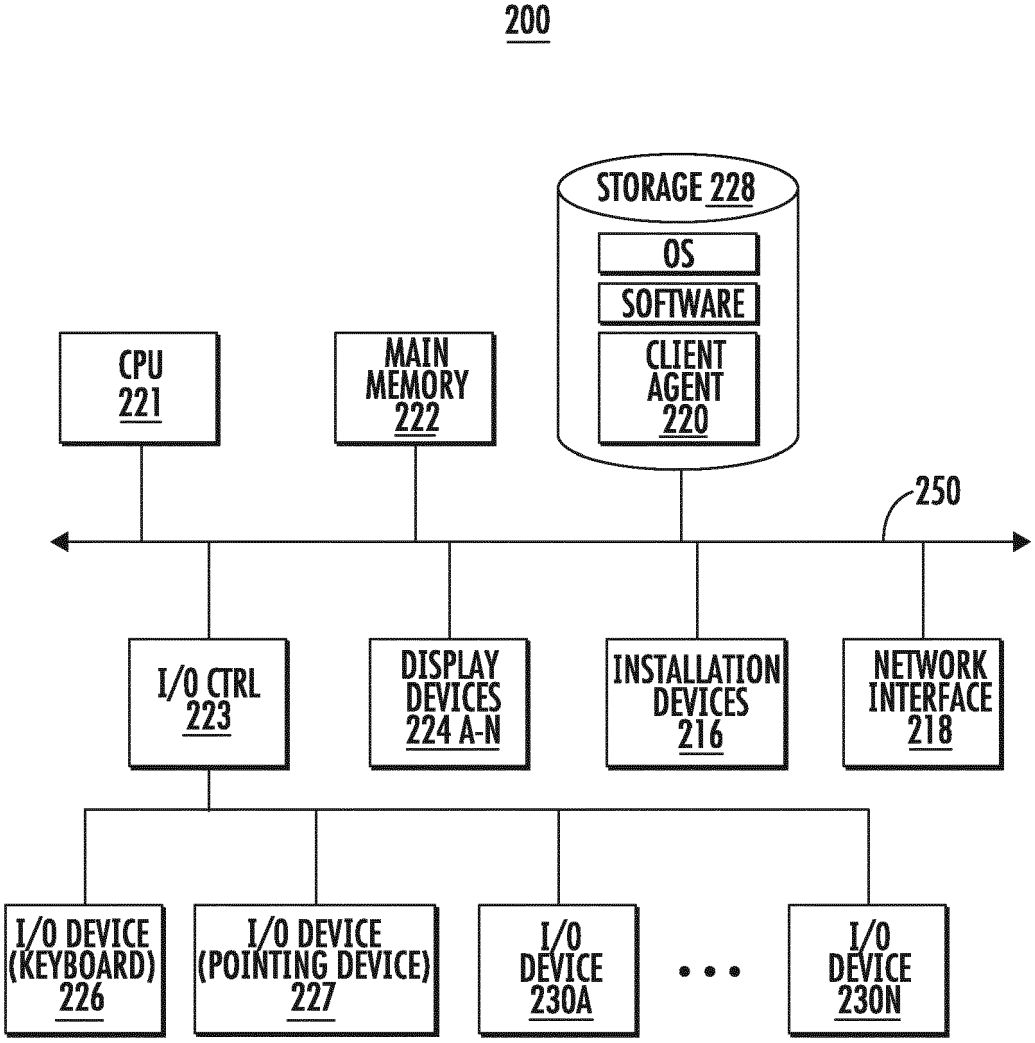
200
STORAGE 228
OS
SOFTWARE
CLIENT AGENT 220
CPU 221
MAIN MEMORY 222
250
I/O CTRL 223
DISPLAY DEVICES 224 A-N
INSTALLATION DEVICES 216
NETWORK INTERFACE 218
I/O DEVICE (KEYBOARD) 226
I/O DEVICE (POINTING DEVICE) 227
I/O DEVICE 230A
I/O DEVICE 230N

FIG. 2

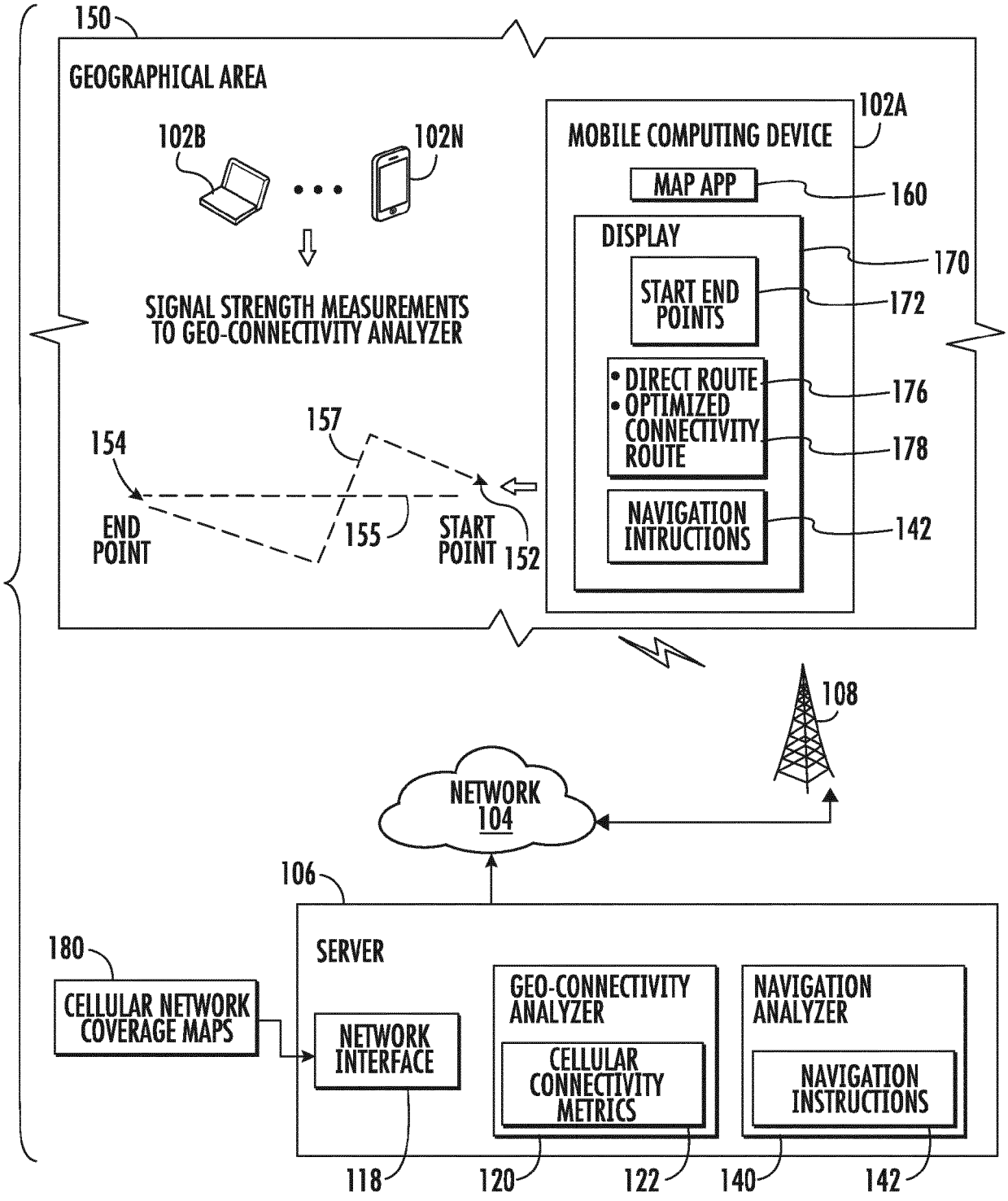
150
GEOGRAPHICAL AREA
102B
102N
SIGNAL STRENGTH MEASUREMENTS TO GEO-CONNECTIVITY ANALYZER
154
157
END POINT
155
START POINT
152
102A
MOBILE COMPUTING DEVICE
MAP APP
160
DISPLAY
170
START END POINTS
172
• DIRECT ROUTE
• OPTIMIZED CONNECTIVITY ROUTE
176
178
NAVIGATION INTRUCTIONS
142
108
NETWORK 104
106
SERVER
180
CELLULAR NETWORK COVERAGE MAPS
NETWORK INTERFACE
GEO-CONNECTIVITY ANALYZER
CELLULAR CONNECTIVITY METRICS
NAVIGATION ANALYZER
NAVIGATION INSTRUCTIONS
118
120
122
140
142

FIG. 3

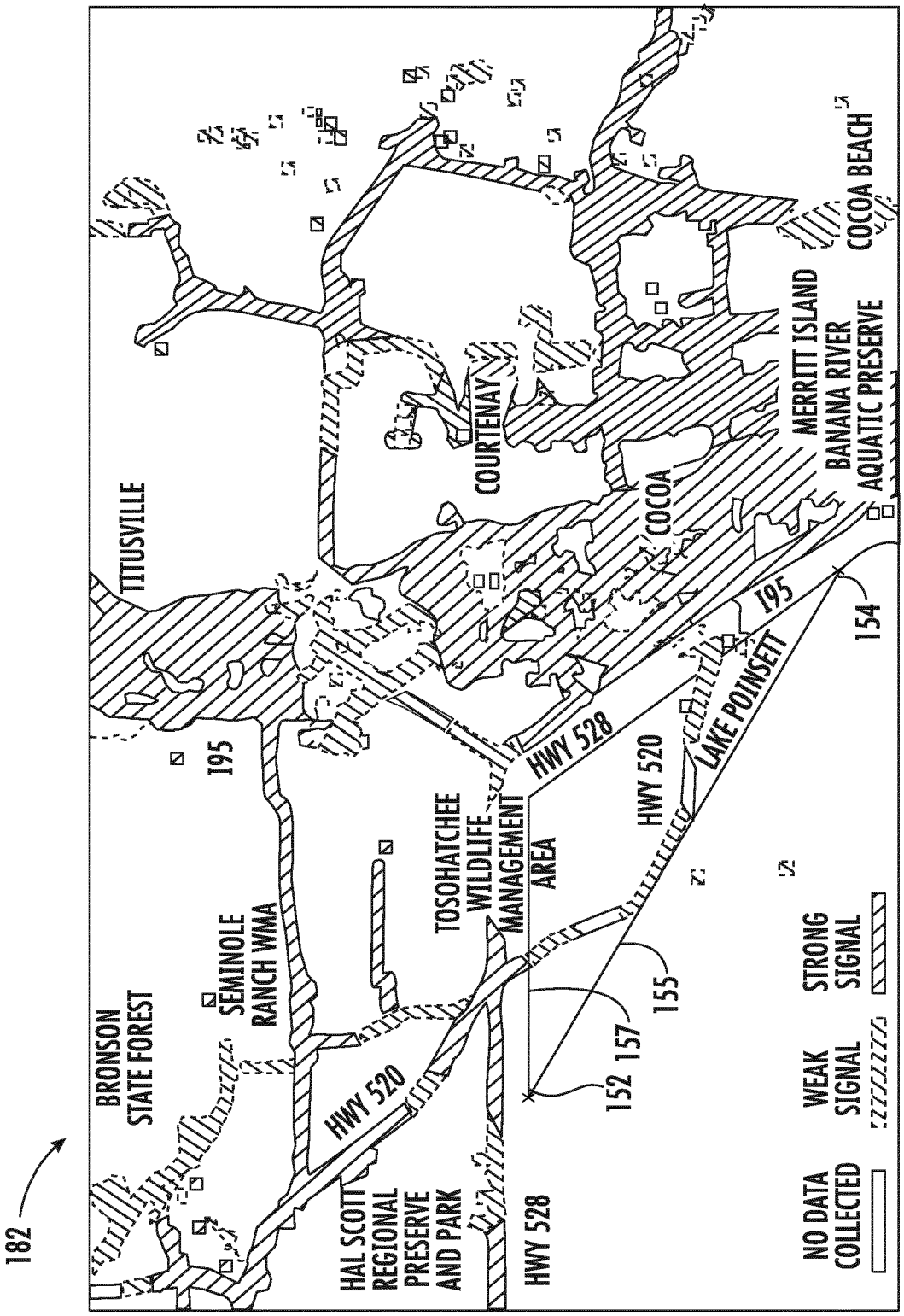
182
BRONSON STATE FOREST
SEMINOLE RANCH WMA
HAL SCOTT REGIONAL PRESERVE AND PARK
HWY 520
HWY 528
TOSOHATCHEE WILDLIFE MANAGEMENT AREA
TITUSVILLE
195
COURTENAY
COCOA
MERRITT ISLAND
BANANA RIVER AQUATIC PRESERVE
COCOA BEACH
LAKE POINSETT
154
155
157
152
NO DATA COLLECTED
WEAK SIGNAL
STRONG SIGNAL

FIG. 4

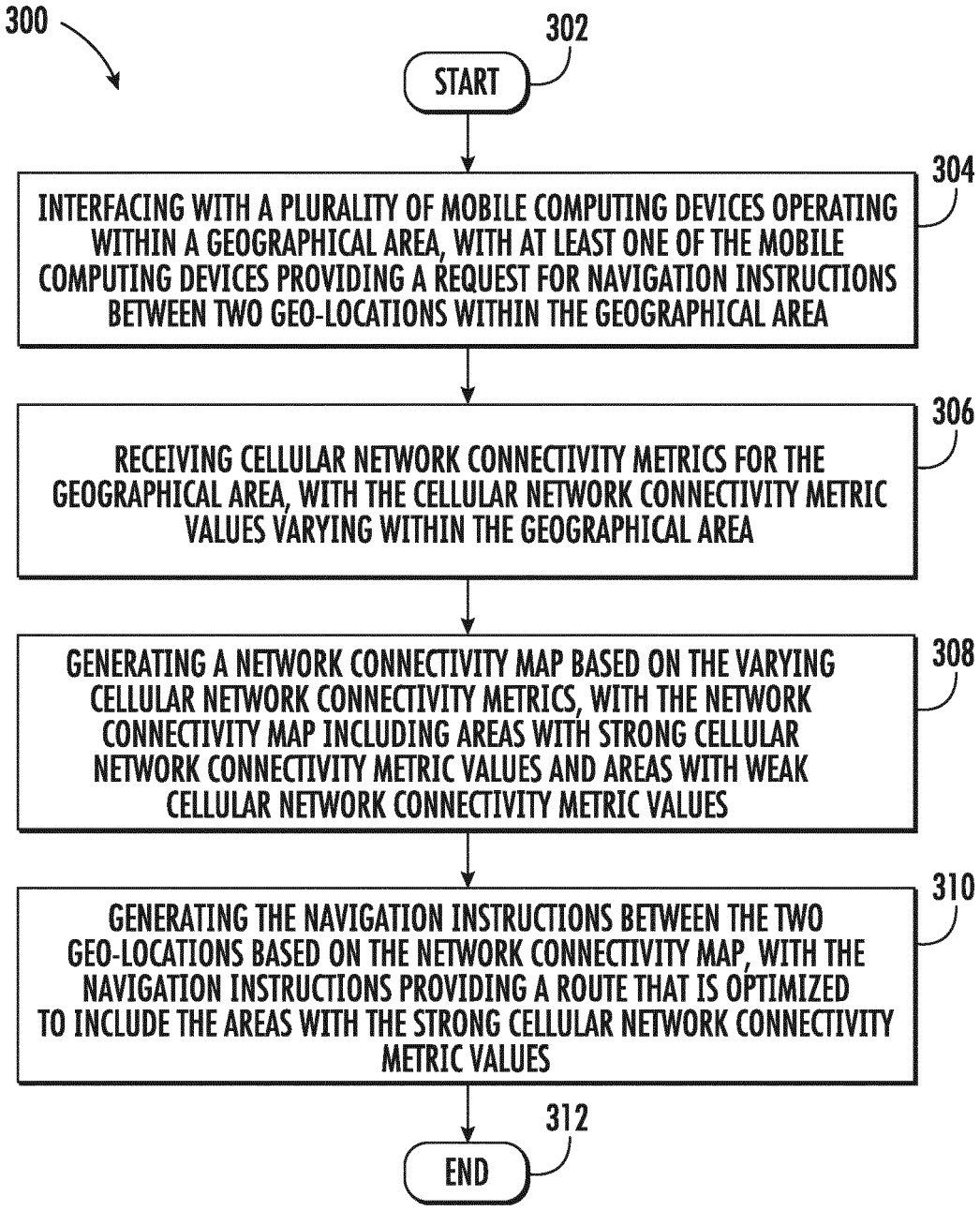
300
302
START
304
INTERFACING WITH A PLURALITY OF MOBILE COMPUTING DEVICES OPERATING WITHIN A GEOGRAPHICAL AREA, WITH AT LEAST ONE OF THE MOBILE COMPUTING DEVICES PROVIDING A REQUEST FOR NAVIGATION INSTRUCTIONS BETWEEN TWO GEO-LOCATIONS WITHIN THE GEOGRAPHICAL AREA
306
RECEIVING CELLULAR NETWORK CONNECTIVITY METRICS FOR THE GEOGRAPHICAL AREA, WITH THE CELLULAR NETWORK CONNECTIVITY METRIC VALUES VARYING WITHIN THE GEOGRAPHICAL AREA
308
GENERATING A NETWORK CONNECTIVITY MAP BASED ON THE VARYING CELLULAR NETWORK CONNECTIVITY METRICS, WITH THE NETWORK CONNECTIVITY MAP INCLUDING AREAS WITH STRONG CELLULAR NETWORK CONNECTIVITY METRIC VALUES AND AREAS WITH WEAK CELLULAR NETWORK CONNECTIVITY METRIC VALUES
310
GENERATING THE NAVIGATION INSTRUCTIONS BETWEEN THE TWO GEO-LOCATIONS BASED ON THE NETWORK CONNECTIVITY MAP, WITH THE NAVIGATION INSTRUCTIONS PROVIDING A ROUTE THAT IS OPTIMIZED TO INCLUDE THE AREAS WITH THE STRONG CELLULAR NETWORK CONNECTIVITY METRIC VALUES
312
END

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 18 19 1999

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2013/124087 A1 (BAUCHOT FREDERIC [FR] ET AL) 16 May 2013 (2013-05-16) * paragraphs [0037] - [0066] *	1-3, 7-10, 14-17 4-6, 11-13, 18-20	INV. G01C21/34 H04W76/00 H04W16/00
X	US 9 086 291 B1 (BHATIA LALIT TULSIDAS [US] ET AL) 21 July 2015 (2015-07-21) * column 4, lines 43-59; figure 3 *	1,8,15	
Y	US 2014/379252 A1 (SOROKIN LENJA [DE] ET AL) 25 December 2014 (2014-12-25) * paragraph [0026] *	4-6, 11-13, 18-20	
Y	US 2017/314940 A1 (DAVE SWAPNIL R [US] ET AL) 2 November 2017 (2017-11-02) * paragraph [0037] *	4-6, 11-13, 18-20	
X	WO 2009/156554 A1 (ELEKTROBIT WIRELESS COMM OY [FI]; CASEY THOMAS [FI]) 30 December 2009 (2009-12-30) * page 14, line 30 - page 15, line 8; figure 6 *	1,8,15	TECHNICAL FIELDS SEARCHED (IPC) G01C H04W

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	5 March 2019	Asthalter, Tanja

CATEGORY OF CITED DOCUMENTS

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05-03-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013124087 A1	16-05-2013	US 2010153001 A1	17-06-2010
		US 2013124086 A1	16-05-2013
		US 2013124087 A1	16-05-2013
US 9086291 B1	21-07-2015	NONE	
US 2014379252 A1	25-12-2014	DE 102013211980 A1	08-01-2015
		US 2014379252 A1	25-12-2014
US 2017314940 A1	02-11-2017	US 2014067257 A1	06-03-2014
		US 2015142301 A1	21-05-2015
		US 2016076895 A1	17-03-2016
		US 2017314940 A1	02-11-2017
WO 2009156554 A1	30-12-2009	NONE	

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